ESC201T : Introduction to Electronics

L8: Circuit Analysis-Summary

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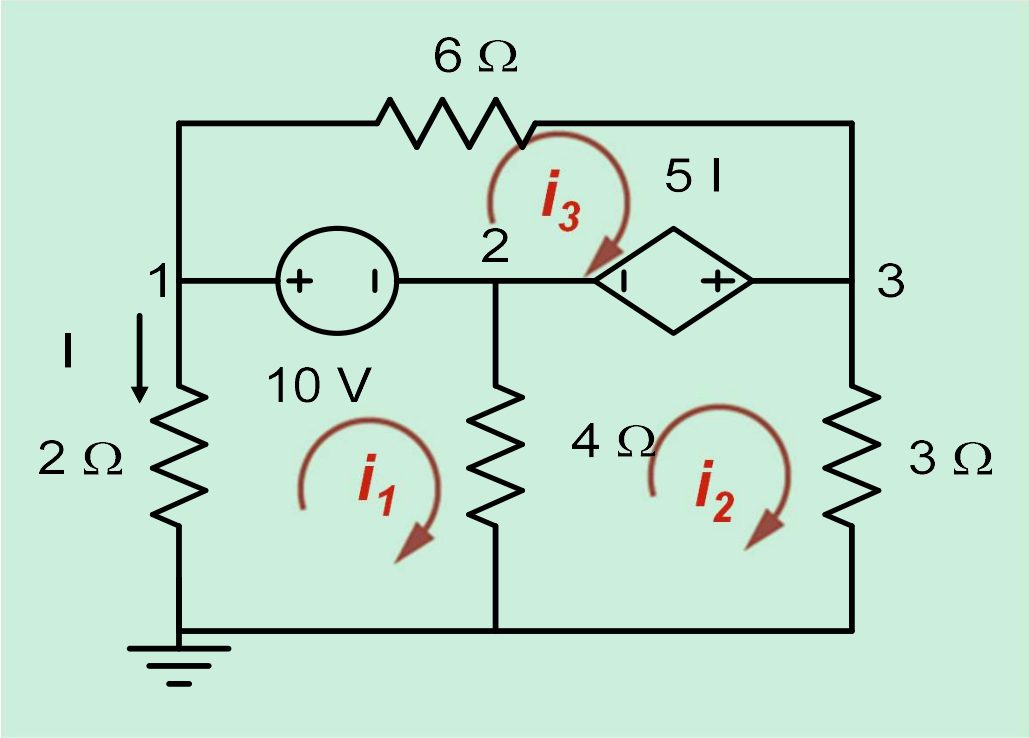
Circuit Analysis Tools

1. Nodal Analysis
2. Mesh Analysis
3. Re-use methodology
4. Superposition
5. Thevenin Equivalent circuit
6. Norton equivalent circuit
7. Source Transformation

Mesh Analysis



$$2i_1 + 10 + (i_1 - i_2) \times 4 = 0 \quad (1)$$

$$4 \times (i_2 - i_1) - 5 \times i + i_2 \times 3 = 0 \quad (2)$$

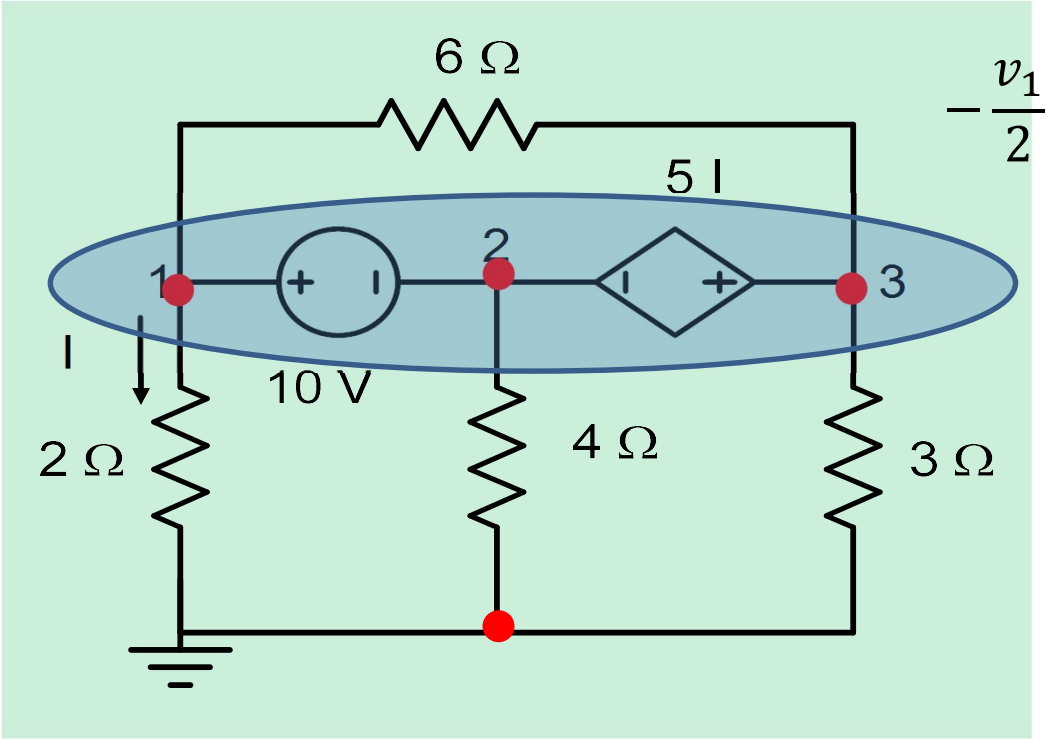
$$6i_3 + 5i - 10 = 0 \quad (3)$$

$$i = -i_1 \quad (4)$$

$$i_1 = -1.52A; i_2 = 0.217A; i_3 = 0.4A$$

$$v_2 = 4 \times (i_1 - i_2) = -6.95V$$

Nodal Analysis



$$-\frac{v_1}{2}+\frac{v_3-v_1}{6}-\frac{v_2}{4}-\frac{v_3}{3}+\frac{v_1-v_3}{6}=0$$

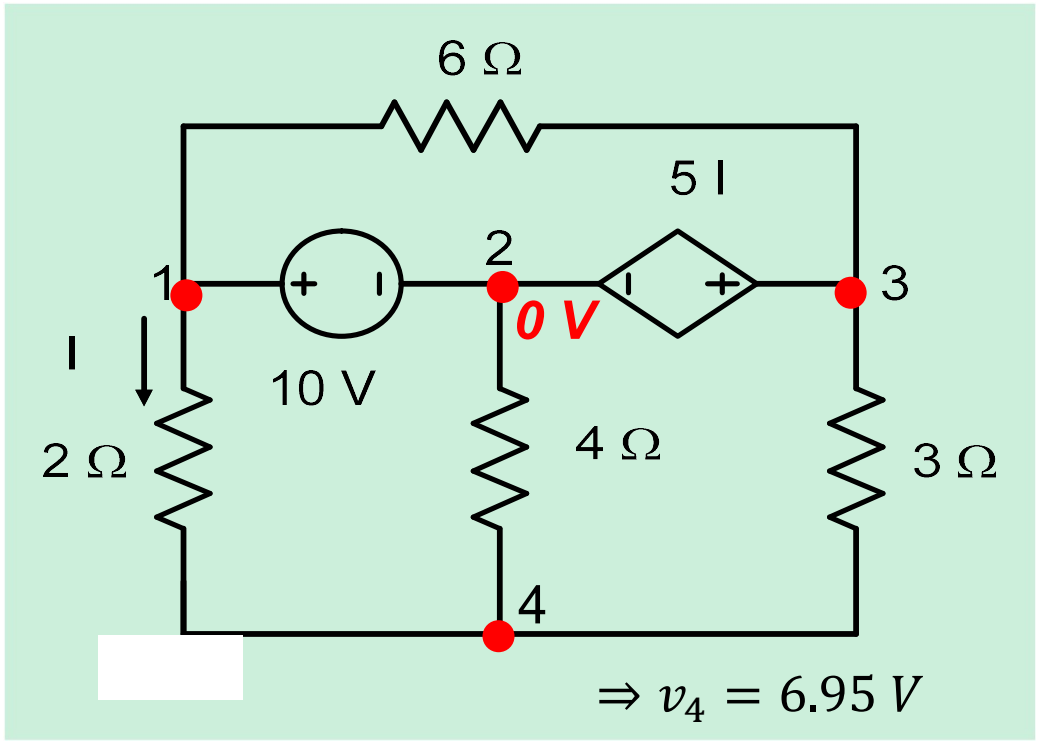
$$v_1 - v_2 = 10$$

$$v_3 - v_2 = 5i$$

$$i=\frac{v_1}{2} \Rightarrow v_3 - v_2 = 2.5v_1$$

$$\Rightarrow v_2 = -6.95\ V$$

Nodal Analysis



$\Rightarrow v_4 = 6.95\ V$

$v_1 = 10\ V\ ; v_2 = 0\ V$

$$v_3 = 5i = 5 \times \frac{10 - v_4}{2}$$

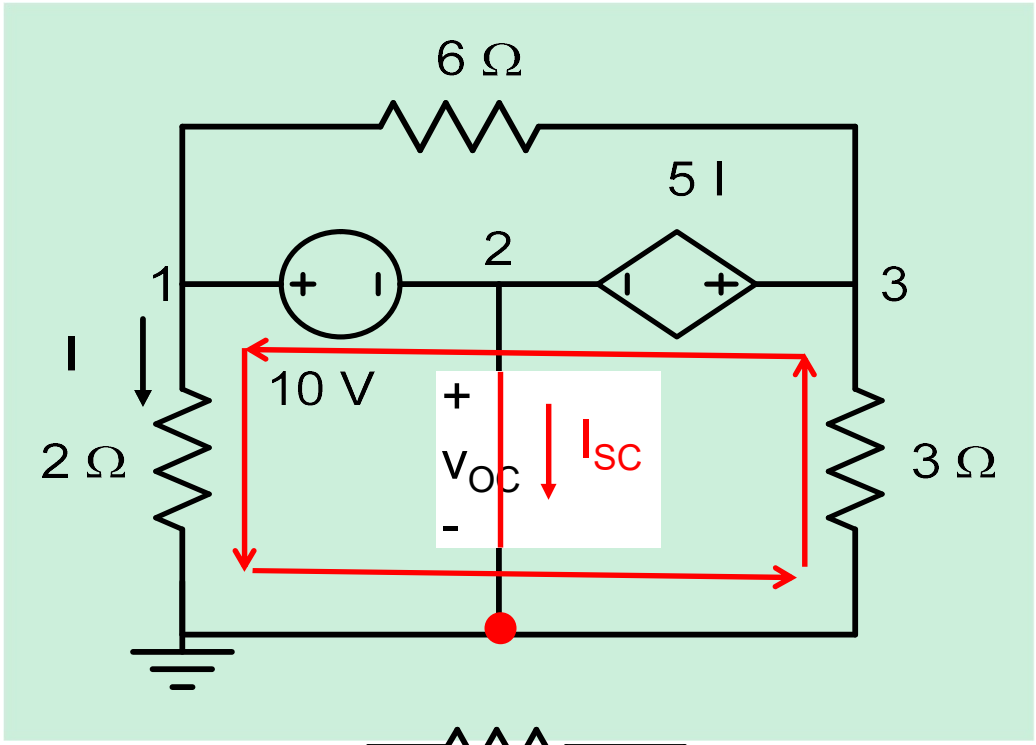
KCL at node 4

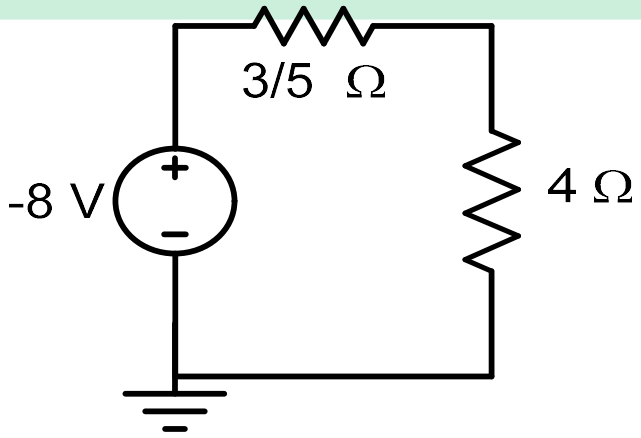
$$\frac{10 - v_4}{2} + \frac{0 - v_4}{4} + \frac{v_3 - v_4}{3} = 0$$

$$v_4 - v_2 = 6.95\ V \Rightarrow v_2 = v_4 - 6.95 = -6.95\ V$$

$$v_1 - v_4 = 10 - 6.95\ V = 3.04 \Rightarrow v_1 = v_4 + 3.04 = 3.04\ V$$

Thevenin equivalent circuit





$$3i + 5i - 10 + 2i = 0$$

$$\Rightarrow i = 1$$

$$v_1 = 2V \Rightarrow v_{OC} = v_2 = -8V$$

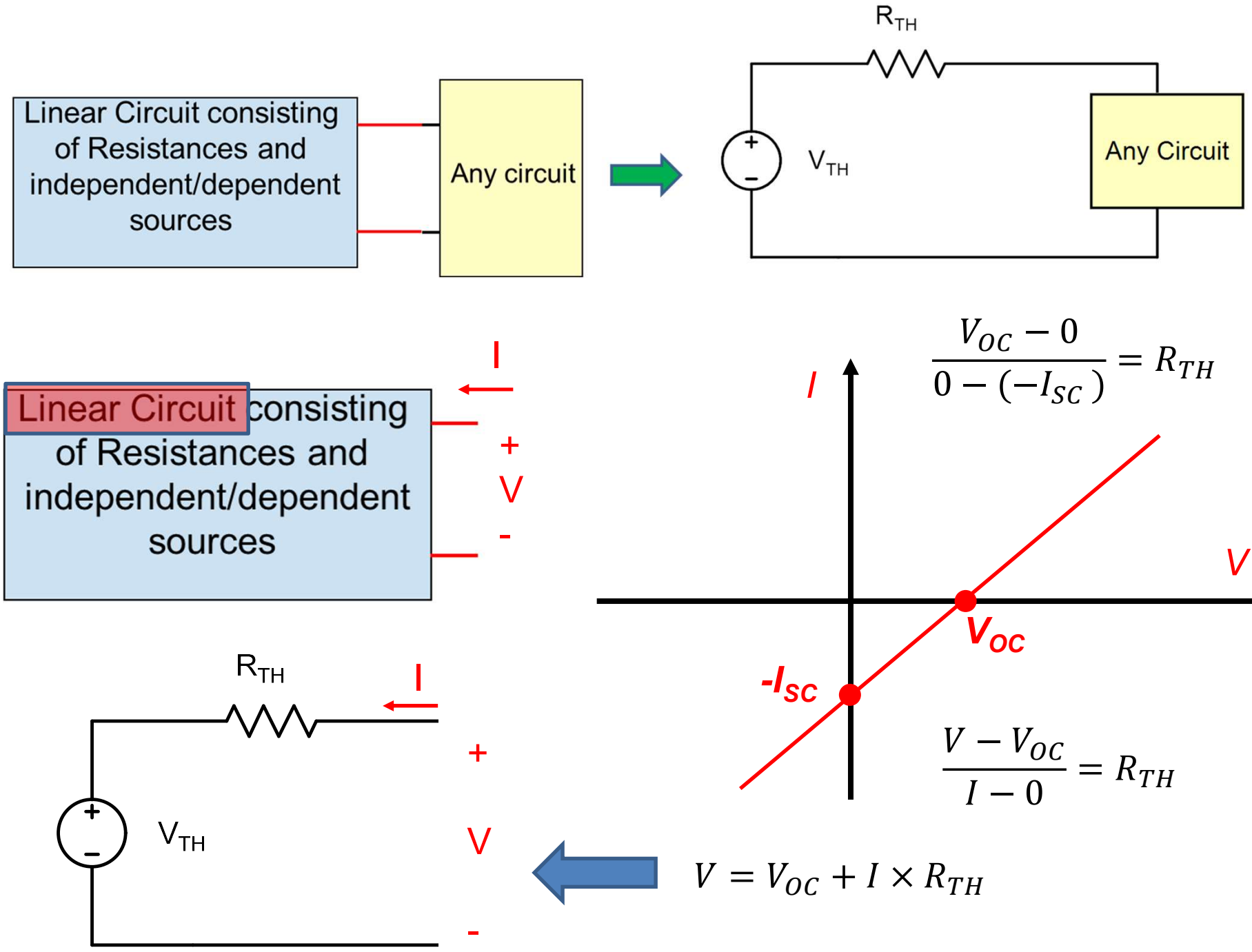
$$\Rightarrow i = \frac{10}{2} = 5A$$

$$\frac{10}{2} + i_{SC} + \frac{25}{3} = 0$$

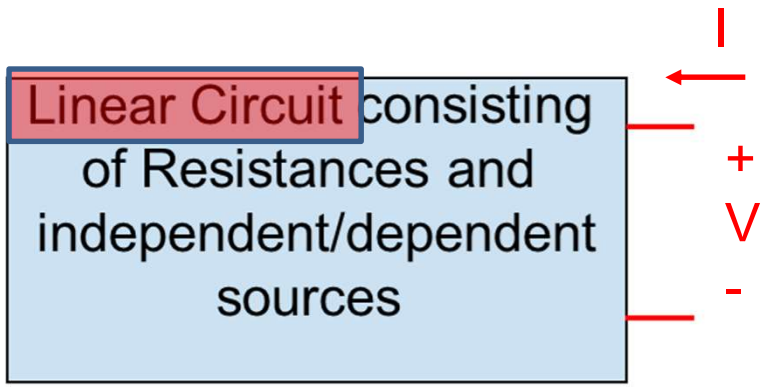
$$\Rightarrow i_{SC} = -\frac{40}{3}$$

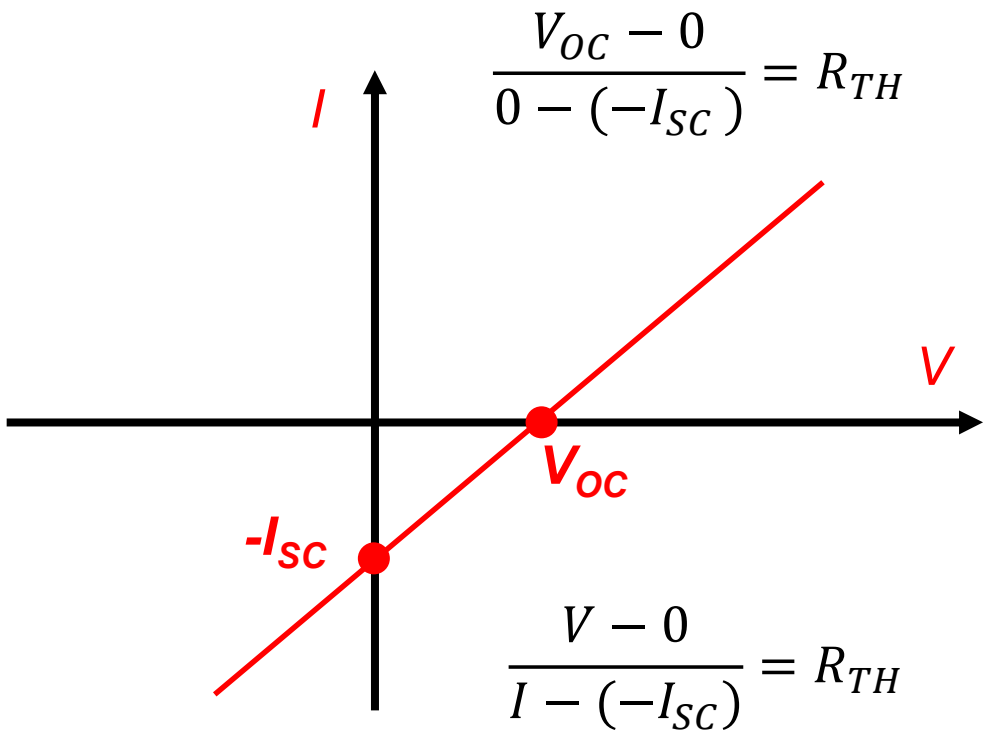
$$R_{TH} = \frac{v_{OC}}{i_{SC}} = \frac{3}{5}\Omega$$

$$v_2 = -8 \times \frac{4}{4 + \frac{3}{5}} = -6.95\ V$$


Linear Circuit consisting of Resistances and independent/dependent sources
Any circuit
R_{TH}
V_{TH}
Any Circuit
Linear Circuit consisting of Resistances and independent/dependent sources
I
+
V
-
$\frac{V_{OC} - 0}{0 - (-I_{SC})} = R_{TH}$
I
V
V_{OC}
$-I_{SC}$
$\frac{V - V_{OC}}{I - 0} = R_{TH}$
R_{TH}
I
+
V_{TH}
V
-
$V = V_{OC} + I \times R_{TH}$

Linear Circuit consisting of Resistances and independent/dependent sources

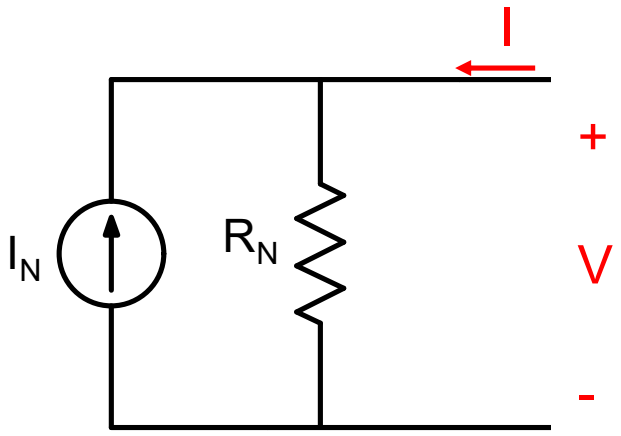




$$\frac{V_{OC} - 0}{0 - (-I_{SC})} = R_{TH}$$

$$\frac{V - 0}{I - (-I_{SC})} = R_{TH}$$

$$I = -I_{SC} + \frac{V}{R_{TH}}$$



$$I = -I_N + \frac{V}{R_{TH}}$$